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AND CENTRAL VENOUS CATHETER INFECTIONS
IN THE ACUTELY ILL PATIENT

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COLLEGE OF NURSING
In Partial Fulfillment of the Requirements
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In the Graduate College
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ABSTRACT

The purpose of this study was to describe the relationship between intrinsic and extrinsic factors and central venous catheter infections in acutely ill patients. Intrinsic factors (inherent) included sex, age, diagnoses, surgical procedures, and medical history. Extrinsic factors (external) included central venous catheter variables and other invasive medical devices. Nosocomial central venous catheter infections were categorized as catheter related bacteremias and site infections.

The nonrandomized convenience sample consisted of 30 subjects who had central venous catheters in place less than 48 hours and who were able to give informed consent. A descriptive design was used and Pearson Correlational Coefficients were computed to examine the relationships between intrinsic factors, extrinsic factors and central venous catheter infections. Two cases of catheter related bacteremia were identified. No cases of site infection were documented. No significant relationships between intrinsic factors and central venous catheter infections were found. Four extrinsic factors showed a significant relationship to redness, a sign of site infection.

CHAPTER 1

INTRODUCTION

The purpose of this research was to describe the relationship between intrinsic and extrinsic factors and central venous catheter infections in acutely ill patients. Chapter one provides an overview of the problem. Central venous catheters are described and the research questions are stated. The chapter concludes with the proposed significance of the study.

Overview of the Problem

Nosocomial infections continue to be a major concern of the health care industry. Nosocomial infections are infections produced by microorganisms that the patient acquires during hospitalization (Brachman, 1987). Hospital acquired infections may be a result of either exogenous (extrinsic) or endogenous (intrinsic) factors. Exogenous infections occur when organisms are transferred to the body from another source such as contaminated equipment or the environment. Endogenous or autogenous infections are caused by the patient's own flora (Jemison-Smith & Gallagher, 1985). Nosocomial infections are classified according to the site of infection: surgical wound, urinary tract, pneumonia or respiratory tract, bacteremia or blood

(Haley & Garner, 1986), wounds other than surgical, intestinal, and burns (Thompson, 1987).

Nosocomial bacteremia is defined as "a clinically important blood culture positive for a bacterium or fungus that is obtained more than 48 hours following hospitalization" (Hamory, 1987, p. 283). Primary bacteremias can occur without any recognizable focus of infection. If a source of infection is not identified and a venous catheter is in place, the venous catheter becomes the suspected source of primary bacteremia. Secondary bacteremias show the same organism in the blood culture that is found at another site in the body. Maki (1986, p. 561) states that "one-third of all outbreaks of nosocomial bacteremia derive from infusion therapy in some form." While bacteremias account for only 7.5% of all nosocomial infections (Hamory, 1989), they represent 25% of the deaths attributed to nosocomial infections (Wenzel, 1987).

Each year nearly three million central venous catheters are used in the United States (Gil, Kruse, Thill-Baharazian & Carlson, 1989). The advent of the multiple-lumen central venous catheter in the 1980s, has resulted in the steady increase in the utilization of this form of convenient intravenous therapy. Hamory (1987) reviewed six clinical research studies that described the complications and infections associated with central venous catheters.

The observed rate of bacteremia ranged from 3.8% to 21% (mean = 4.3%). In Intensive Care Units, 33% to 45% of the patients are diagnosed with pulmonary and bacteremial nosocomial infections, yet patients in Intensive Care Units only occupy 5% to 10% of the hospital beds (Thompson, 1987). The high incidence of bacteremia in Intensive Care Units is related to the high risk patient who is critically ill and usually requires multiple intravascular devices for monitoring and the administration of intravenous fluids. The purpose of this study was to describe the relationship between intrinsic and extrinsic factors and nosocomial central venous catheter infections in acutely ill patients.

Central Venous Catheters

Central venous catheters are used for patients who require multiple intravenous lines for the administration of fluids, blood, medications or total parenteral nutrition (TPN) that cannot be administered through a peripheral catheter. Single-, double-, or triple-lumen catheters are available, and the type of catheter selected is based on the needs of the patient. Single-lumen catheters are used for patients who require one intravenous source for fluids such as TPN. The multiple-lumen central venous catheter has several advantages: central venous pressure monitoring; TPN; continuous or intermittent infusion of medications;

administration of viscous fluids, blood or blood products; venous blood sampling and simultaneous infusion of incompatible drugs (Recker & Metzler, 1984). The multiple-lumen catheter may eliminate the need for insertion of intravenous catheters through surgical incisions or placement of long-term central venous catheters such as Broviacs, Hickmans, and Mediports (Farber, 1988).

The most common size of a multiple-lumen central venous catheter is 7 french and 30 centimeters in length (Figure 1). The polyurethane catheter is radiopaque so that proper placement can be assessed by x-ray prior to administration of intravenous fluids. Each lumen has an individual port that is labeled distal, proximal and middle to correspond with the position of the exit port (Recker & Metzler, 1984). The distal line is a 16 gauge lumen with a volume of 0.5 ml. The distal lumen is the shortest line available and is used for central venous pressure monitoring, blood administration or withdrawal, colloidal solutions, medications and large volumes of fluids. Located midway between the distal and proximal ports, the middle lumen is an 18 gauge lumen with a 0.35ml volume. The middle lumen is used to administer TPN as well as all other intravenous fluids. If the middle lumen is used for TPN, no other fluids are administered and blood is not withdrawn through this port. The proximal port is an 18 gauge line with a volume of 0.35ml. The proximal

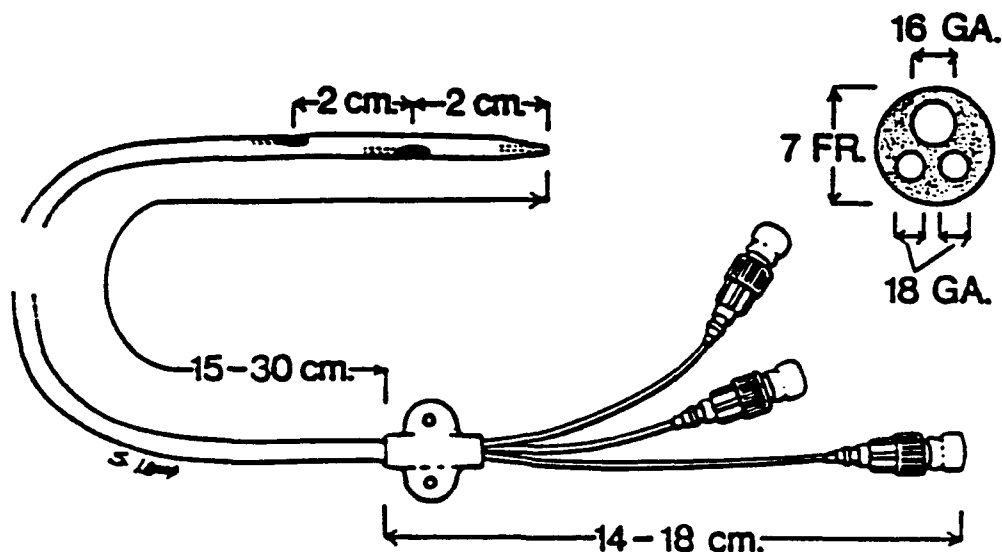


Figure 1. Multiple-lumen central venous catheter, 7 French polyurethane catheter featuring three internal lumens: 18 gauge proximal, 18 gauge middle and 16 gauge distal. Note. From "Clinical experience with the multiple lumen central venous catheter" by Kaufman, Rodriguez, McFadden and Brolin, 1986, Journal of Parenteral and Enteral Nutrition, 10, p. 488. Copyright by The American Society for Parenteral and Enteral Nutrition. Reprinted with permission.

port, the longest intravenous line, is used for blood administration or withdrawal, administration of intravenous fluids and medications (Warren, 1985). When a lumen is not being used, the port is sealed with a heparin lock adapter and periodically flushed with a solution of heparin and normal saline as directed by hospital policy.

Pathogenesis of Central Venous Catheter Infections

The two most common sources of bacteremic infection in any intravascular line is the cannula and the insertion site (Maki, 1986). After the central venous catheter is inserted into the bloodstream, a fibrin sheath forms around the cannula which attracts bacteria. Bacteria can either migrate from the skin surface, be administered by contaminated intravenous fluids or travel through the blood stream from some other site of infection to attach to the fibrin sheath. After colonization of the fibrin sheath, the bacteria replicate and are released into the bloodstream when symptoms may develop (Hamory, 1987).

Intrinsic and Extrinsic Factors

Risk factors which contribute to the development of nosocomial infections can be categorized as either intrinsic or extrinsic factors. Intrinsic factors are those that are inherent in each individual. Intrinsic factors

include age, sex, nutritional status, medical history, primary diagnosis, secondary diagnosis, surgical procedures, and immunosuppression. Extrinsic factors are external to the patient. Extrinsic factors include central venous catheter insertion variables such as type of catheter, experience of person who inserted catheter, geographic location where the insertion procedure occurred, physical site of insertion, type of fluids administered through the catheter, complications during insertion of the catheter, length of time the catheter is left in place, and whether or not the catheter is sutured to the skin. Invasive medical devices, including urinary catheters, nasogastric tubes, tracheostomy tubes, endotracheal tubes, wound drainage tubes, intraventricular catheters and arterial catheters are also considered to be extrinsic factors. Peripheral intravenous fluids and intravenous medications may also fall into the extrinsic category.

Purpose

The purpose of this study was to describe the relationship between intrinsic and extrinsic factors and central venous catheter nosocomial infections in the acutely ill patient.

Research Questions

The research questions were as follows:

1. What is the relationship between intrinsic factors and nosocomial infections in central venous catheters?
2. What is the relationship between extrinsic factors and nosocomial infections in central venous catheters?

Significance

Central venous catheters play a key role in the development of nosocomial infections (Maki, 1986). Infection rates for central venous catheters have been reported to range from 3.8% to 21% (Hamory, 1987). The skin has been identified as the most common source of organisms which cause catheter related bacteremia. Coagulase-negative staphylococci, *Staphylococcus aureus*, *Enterobacter aerogenes*, *Escherichia coli*, and *Candida* species are the most frequently identified organisms which may contribute to the development of bacteremia (Speer, 1990).

Contamination is the key to the development of central venous catheter infections (Farber, 1988; Hadaway, 1989; Hamory, 1987; Hamory 1989; Maki, 1986). The most common sites of contamination are the insertion and exit sites, subcutaneous tunnels, catheter ports, intravenous tubing, and intravenous fluids. Adherence to strict aseptic techniques during insertion of the central venous

catheter, dressing changes, intravenous tubing changes, replacement and irrigation of heparin lock adapters, and withdrawal of blood will decrease infection rates.

Hospitals with reported central venous catheter infection rates of 25% to 30% for patients receiving TPN have reduced infection rates to 3% to 5% when a specialized team was established to insert the catheters and perform all the catheter maintenance (Speer, 1990). Nelson, Kien, Mohr, Frank and Davis (1986) evaluated 60 pediatric patients who received TPN through central venous catheters (N=75). During the first 16 months of the study, the surgical residents were responsible for dressing changes and maintenance care of the central venous catheters. The last five months of the study a specially trained nurse was responsible for dressing changes and maintenance care. The infection rate for patients with central venous catheters cared for by surgical residents was 28.8% compared to 3.3% in the patients cared for by a specially trained nurse. In many hospitals specially trained personnel are not available to care for central venous catheters. Therefore, teaching nurses to assess the patient for signs of infection and perform proper aseptic techniques when managing the central venous catheter may decrease infection rates associated with central venous catheters. Identification of the relationship between intrinsic and extrinsic factors and

central venous catheter infections will provide the base for nursing interventions to prevent or decrease these nosocomial infections.

Summary

Central venous catheters have been identified as a major contributor of nosocomial infections, bacteremia and site infections. Since most bacteremias caused by intravenous devices are due to contamination at some point in the system, they are basically preventable. The purpose of this study was to describe extrinsic and intrinsic factors that contribute to bacteremia and site infections. Once the factors are identified, nursing interventions can be implemented which prevent or decrease these infections.

CHAPTER 2

CONCEPTUAL FRAMEWORK

The conceptual framework which describes the relationship between intrinsic and extrinsic factors and the development of nosocomial central venous catheter infections is presented in Chapter two. Figure 2 depicts the theorized relationships at the construct and concept levels. In Chapter two each level of the conceptual framework is described and the relationships are substantiated with a review of the literature.

Construct Level

Intrinsic Factors

Intrinsic factors are identified as those inherent in the individual or host. The hospitalized patient is at risk of developing a nosocomial infection due to a compromised defense system. Nosocomial pathogens usually have a low virulence and seldom cause illness in healthy individuals. The risk of infection depends on a compromised defense system and an introduction of a sufficient number of microorganisms to establish an infection (Massanari & Hierholzer, 1987). Acute or chronic illness, trauma, and surgery effect the integrity of the defense mechanisms and may allow transmission of microorganisms of low virulence

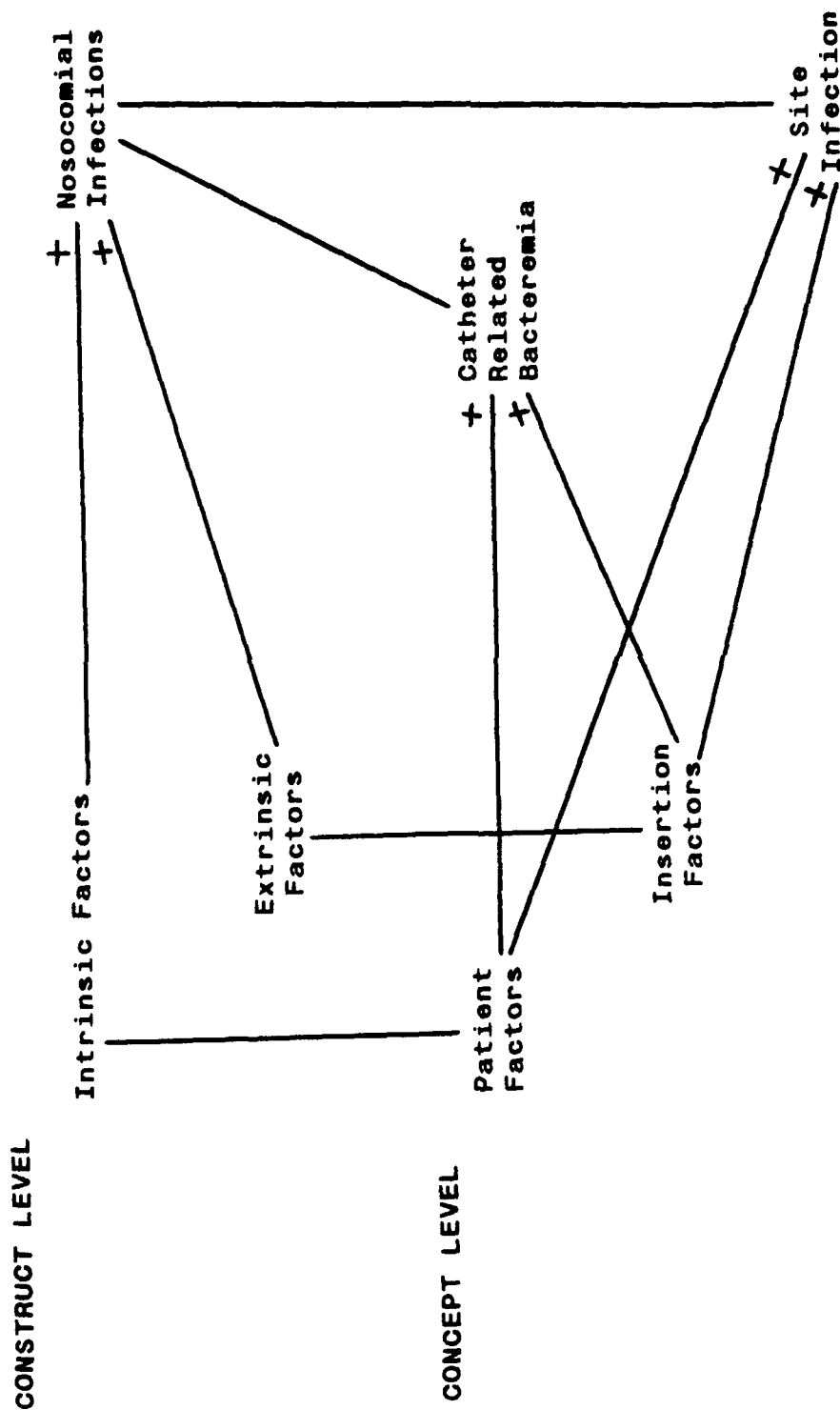


Figure 2. Conceptual framework describing the relationship between intrinsic and extrinsic factors and nosocomial infections.

(Kaye, 1982). Preexisting infections, immunosuppression, decreased cardiac output and prolonged hospitalization have also been identified as contributing factors to nosocomial catheter infection rates (Plit, Lipman, Eidelman & Gavaudan, 1988).

Extrinsic Factors

Extrinsic factors have been identified as those external to the individual or host. Specifically, invasive medical devices are major contributors to nosocomial infections (Maki, 1986; Massanari & Hierholzer, 1987). Urinary, arterial, and hemodialysis catheters, nasogastric, tracheostomy, endotracheal, chest and wound drainage tubes are examples of invasive medical devices.

Factors related to insertion of central venous catheters are also considered extrinsic factors. Catheter insertion variables play an important role in the development of central venous catheter (CVC) infections. Plit, et al. (1988) identified the following insertion variables which contribute to the development of nosocomial infections: insertion technique (aseptic technique, repeated venipuncture, cutdown versus percutaneous placement, repositioning after x-ray, suturing of catheter to the skin); duration of time the catheter is left in place; site of catheter insertion; catheter usage (total

parenteral nutrition, medication, intravenous fluid administration, blood administration, withdrawal of blood specimens, central venous pressure monitoring); and care of the insertion site. Kaye (1982) identified several other factors that may contribute to nosocomial infections. Motion of the catheter may facilitate entry of microorganisms and encourage phlebitis. Other factors include the presence of monitoring devices within the infusion system, manipulation of the delivery system (addition of medications, replacement of intravenous tubing or heparin lock adapters, irrigation of catheter lumens) and the type of fluid infused.

Nosocomial Infections

A nosocomial infection is an "infection that develops within a hospital or is produced by microorganisms acquired during hospitalization" (Brachman, 1987, p. 4). An infection is the replication of an organism in the tissues of a host that may or may not manifest clinical symptoms. Both intrinsic and extrinsic factors play a critical role in the transmission of infection. The transmission of infection depends on three interrelated factors: the infectious agent (extrinsic factor), the mode of transmission (extrinsic factor) and a susceptible host (intrinsic factor). An agent is necessary for infection

to occur. In the hospital, the agent may be a bacterium, virus, fungus or parasite. Several factors influence the ability of the agent to cause disease or infection (pathogenicity) including: virulence (measure of the severity of disease), invasiveness (ability of microorganism to invade tissues), dose (number of organisms needed to cause an infection), specificity (affinity to the host), reservoir (site where the organism lives and reproduces), source (object from which infectious agent passes to the host) and period of infectivity (ability of an organism to spread from a source to a host) (Brachman, 1987).

The second link in the chain of infection is the movement of organisms from the source to the host or the mode of transmission. Organisms are spread by four different routes: contact, common-vehicle, airborne and vectorborne. Diseases or infections that are spread by contact require exposure to the source either directly (person-to-person), indirectly (microorganism is passed to an intermediate object) or droplet spread (passage of infectious agent through air). Illnesses spread via the common-vehicle route require the contamination of an inanimate source and the ability of the microorganism to reproduce. A third form of disease transmission is airborne spread, where the organisms are contained within droplet nuclei or dust particles. Airborne spread differs from

droplet spread because the particles may stay suspended for long periods of time. Also, airborne transmission is over a greater distance than droplet which is usually confined to a few feet. The final mode of transmission is vectorborne spread which has not been reported as a source of nosocomial infection in the United States (Brachman, 1987).

The third link in the chain of infection is the host. Two factors that influence the development of disease or infection in the host are the site of the transmission of organisms and the host's defense mechanisms. The site of transmission or entrance of the organism into the host's system can occur through the skin, mucous membranes, respiratory tract, gastrointestinal tract and the urinary tract. The organism may or may not cause infection in a site, depending on the normal flora of the system. For example, *Escherichia coli* routinely colonize the gastrointestinal tract and normally does not cause disease in that site. However, if *Escherichia coli* are introduced into the urinary tract, infection may result (Brachman, 1987).

The host's defense mechanisms help fight disease. The human body has two types of defense mechanisms: nonspecific and specific. Nonspecific defense mechanisms include the skin, mucous membranes, some bodily secretions, the local inflammatory response, genetic influence, hormonal factors,

nutritional elements and personal hygiene. Specific defense mechanisms result from natural events or artificially induced events. Natural immunity results from having certain diseases and usually lasts a lifetime. Artificial immunity results from the use of live vaccines, killed vaccines and toxoids (active immunity) or immune serum globulin (serum that contains antibody). A host's response to an organism is individual and may range from the absence of symptoms (no infection), to clinically apparent illness and possibly death (Brachman, 1987).

Concept Level

Patient Factors

Nosocomial infections occur as a result of interactions between multiple intrinsic and extrinsic risk factors. In 1975-76, the Study on the Efficacy of Nosocomial Infection Control (SENIC) Project studied 169,526 patients admitted to acute-care United States hospitals. The purpose of the study was to identify risk factors associated with specific site infections. The factors that exerted the strongest causal influences in all four sites of nosocomial infections (urinary tract, surgical wound, respiratory tract and bacteremia) were length of surgical procedure and the number and type of distinct diagnoses and surgical procedures recorded. Several risk factors had weak

associations with infections occurring in all four sites: age, sex, previous nosocomial infections, and length of preoperative hospitalization. Intrinsic risk factors associated with bacteremia were previous nosocomial infections and immunosuppressive therapy. The findings of the SENIC Project indicated that the "risk of infection is primarily determined by definable causal factors reflecting the patient's underlying susceptibility to infection or the degree to which microorganisms have access to vulnerable body sites" (Haley, 1986, p. 363).

Ehrenkranz, Eckert, and Phillips (1989) used univariate and multiple regression analysis to identify independent risk factors correlated with nosocomial bloodstream infections. The sample consisted of 1,258 patients who received total parenteral nutrition (TPN) through a single-lumen central venous catheter. Sixty-four patients (5.1%) developed 66 episodes of bacteremia. Univariate analysis revealed 15 statistically significant risk factors ($p \leq .05$): collagen-vascular disease, single disease sites, metabolic dysfunction, absence of physiologic disorder, levels of serum albumin, BUN, bilirubin, diagnosed respiratory colonization and/or infection, abnormal chest x-rays, antibiotics, hemodialysis, tracheostomy tube, TPN, any cardiac surgery, and hospital location at onset of infection. A stepwise multiple logistic regression analysis

of the 15 factors resulted in four statistically significant factors ($p \leq .05$): single disease sites, diagnosed respiratory colonization and/or infection, serum albumin and serum BUN levels. A second stepwise multiple logistic regression analysis identified two statistically significant risk factors of nosocomial infections ($p \leq .001$): diagnosed respiratory colonization and/or infection and single disease sites.

Hilton, Haslett, Borenstein, Tucci, Isenberg, and Singer (1988) studied 362 patients with single-lumen and multiple-lumen central venous catheters ($N=502$) to determine infection rates. The study also examined intrinsic and extrinsic factors that could influence central venous catheter infections. The degree of illness, diabetes mellitus, renal failure, TPN, and the use of a guidewire for placement of a new catheter into the preexisting site were found to be significant variables in central venous catheter infections. The overall infection rate for patients with central venous catheters was 11.8%. Eight percent of the patients with single-lumen catheters developed infections and 32% of the patients with multiple-lumen catheters developed infections.

Insertion Factors

Insertion factors play a critical role in the development of bacteremia and site infections in central venous catheters. The site selected for placement of the central venous catheter can be a contributing factor in the development of an infection. The most common placement sites for a central venous catheter are the external and internal jugular veins and the subclavian vein (Figure 3). The most frequently used site of insertion is the subclavian vein, which extends from the outer edge of the first rib to the inner end of the clavicle, where it unites with the internal jugular to form the innominate vein. The subclavian vein insertion site on the chest is easily assessable for dressing changes and site care. The external jugular vein is located on the side of the neck and descends inward to join the subclavian vein. The internal jugular vein descends behind and then to the outside of the internal and common carotid arteries and then joins the subclavian vein. The internal jugular and external jugular veins are easily accessible for catheter insertion. However, movement of the neck, facial hair, long hair and the close proximity of respiratory secretions, make maintenance of an occlusive dressing difficult at the jugular sites. (Hadaway, 1989; Speer, 1990). Pinilla, Ross, Martin and Crump (1983) studied 82 central venous catheters to evaluate the

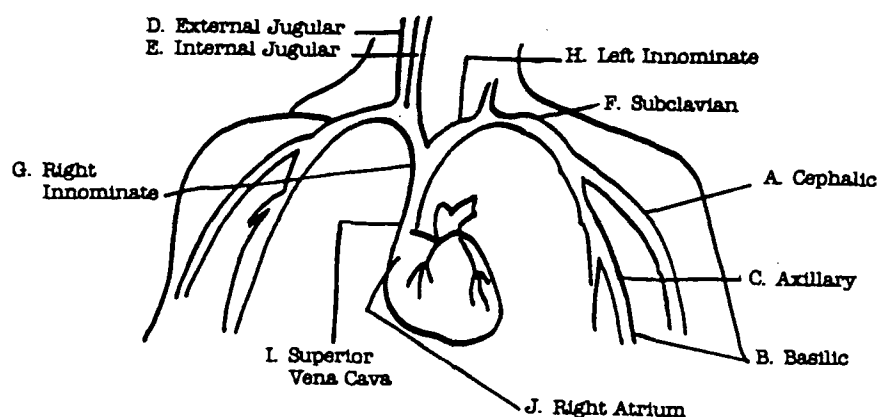


Figure 3. Vascular anatomical structures. **Note.** From "Central venous catheterization: issues associated with the use of single- and multiple-lumen catheters" by E. W. Speer, 1990, Journal of Intravenous Nursing, 13, p. 31. Copyright by J. B. Lippincott Company. Reprinted with permission.

incidence of infection and associated septicemia. The infection rate for internal jugular central venous catheters was 29% and subclavian central venous catheter infections were 7%. Results of data analysis indicated that the risk of septicemia increased if the central venous catheter was in place more than four days. A study conducted at the University of California - Davis Medical Center revealed an internal jugular central venous catheter infection rate of 20% and a subclavian central venous catheter infection rate of 5% (Catheter infection, 1987). A sample size was not reported.

Exchanging a central venous catheter over a guidewire is another factor to be considered in the study of central venous catheter infections. Using aseptic technique, a guidewire is introduced into the central venous catheter. The old central venous catheter is removed and a new central venous catheter is threaded over the guidewire. The guidewire is removed and the catheter is ready for use. Hospital policy will determine if the original catheter tip is sent for culture upon removal. Central venous catheters exchanged because of suspected sepsis should be cultured, and if the culture is positive the new central venous catheter should be removed. The central venous catheter must not be changed over a guidewire in the presence of purulent drainage, erythema, tenderness or induration at the

insertion site (Farber, 1988). Bozzetti, Terno, Bonfanti, Scarpa, Scotti, Ammatuna and Bonalumi (1983) studied the central venous catheter infection rates in patients who had central venous catheters exchanged via a guidewire. Sixty-two patients had a total of 170 catheters exchanged with a guidewire. Central venous catheters were exchanged with a guidewire weekly and if the patient developed an unexplained fever of over 38 degrees centigrade (C) or if there was a clinical suspicion of central venous catheter sepsis. Peripheral blood cultures and catheter tip cultures were obtained when the catheter was exchanged. The mean duration of catheterization was 29.4 days. Central venous catheter infection rate was 10.7%. Three-fourths of the colonized central venous catheters became negative after the first guidewire exchange. Nine percent of negative central venous catheters became positive after the guidewire exchange, however, this rate was below the overall 10.7% infection rate. Powell, Kudsk, Kulich, Mandelbaum and Fabri (1988) studied 126 patients who required single-lumen and multiple-lumen central venous catheters. Sixty-three patients had their central venous catheter replaced by guidewire exchange every three days and 63 patients had their central venous catheter replaced via guidewire for mechanical or septic complications. Patients who had central venous catheter replacement every three days had an

infection rate of 12.7%. Patients who had the central venous catheter replaced for complications had an infection rate of 15.9% (no significant difference). An increased risk of infection was noted in patients who had central venous catheters exchanged via a guidewire by Hilton, et al. (1988). The infection rate of central venous catheters per 100 days was 2.4% for new central venous catheters and 4.4% for central venous catheters inserted over a guidewire. The sample consisted of 362 patients who had a total of 502 central venous catheters inserted, with 55 central venous catheters inserted over a guidewire.

Other insertion factors or variables contribute to the incidence of central venous catheter infections. Sitzman, Townsend, Siler, and Bartlett (1985) found a significant correlation ($p \leq .001$) between the number of attempts made at passing the locator needle through the skin and sepsis. An average of 1.4 attempts to insert the locator needle through the skin (range 1 to 5), did not result in sepsis. An average of 2.1 attempts (range 1 to 6) resulted in sepsis. Duration of catheterization is another important factor. Prager and Silva (1987) studied 162 patients to investigate etiological factors in the colonization of central venous catheters. Colonization of the catheter occurred in 1 to 7 days in 13% (17 of 126 CVCs) and in 8 to 30 days in 43% (23 of 53 CVCs).

Infection rates in patients with single-lumen catheters (SLC) versus double-lumen or triple-lumen catheters (TLC) have also been described. Rose, Pitsch, Karrer, and Moor (1988) evaluated 496 subclavian catheters which were maintained by an intravenous therapy team. The infection rates for patients with single-lumen catheters was 1.6% (4/248) and 4.9% (12/232) for triple-lumen catheters. A significant increase in infections was noted when the catheter was used to infuse TPN (5.7% infection rate for lines with TPN versus 1.14% for lines without TPN). Lee, Buckner, and Sharp (1988) studied infection rates in patients with triple-lumen catheters and single-lumen catheters used to administer TPN. The rate of infection in patients with triple-lumen catheters was 10.4% (32/307) and 4.4% for patients with single-lumen catheters (3/68). Pemberton, Lyman, Lander, and Covinsky (1986) compared infection rates of single-lumen catheters and triple-lumen catheters in surgical and critically ill patients. Infection rates were six times greater in triple-lumen catheters than single-lumen catheters. Yeung, May, and Hughes (1988) studied the infection rates of single-lumen and triple-lumen subclavian catheters. They studied two groups: subjects who received TPN and those who did not receive TPN. Infection rates for patients who received TPN were 4.6% (3/65) for single-lumen catheters and 14.5%

(25/12) for triple-lumen catheters. Infection rates for patients who did not receive TPN were 0.9% (5/580) for single-lumen catheters and 2.8% (9/323) for triple-lumen catheters. McCarthy, Shives, Robison, and Broadie (1987) studied 52 patients who received TPN through 75 catheters. Patients remained in the study when the central venous catheter was inserted into a new site. Intravascular catheter segments cultured positive for 12.8% (5/39) triple-lumen catheters. No positive cultures were found for single-lumen catheters. McCarthy, et al. (1987) also noted that if a triple-lumen catheter had been left inserted more than 5 days, 78% of the patients had developed inflammation and purulent drainage at the skin entry site upon removal of the catheter. In contrast, only 33% of single-lumen catheter sites had developed inflammation or purulent drainage at the time of removal. These studies indicated that the risk of infection was increased in the patient with a multiple-lumen catheter.

Gil et al. (1989) compared the infection rates between single-lumen and triple-lumen catheters and insertion sites. The sample consisted of 145 critically ill patients with 63 single-lumen catheters and 157 triple-lumen catheters. The infection rates per site were 10% for subclavian and 22% for internal jugular. The infection rate for patients with single-lumen catheters was 7.9% (5 of 63) and 3.8%

(6 of 157) for triple-lumen catheters. The rate of sepsis was significantly increased for patients who had catheters left inserted greater than seven days.

The type of occlusive dressing is another extrinsic factor that has been frequently cited to be associated with central venous catheter infections. The type of dressing needed to cover the insertion site, frequency of dressing changes, and the use of disinfectants or antimicrobial ointments at the insertion site continues to be controversial. The two major forms of occlusive dressings are gauze and transparent. The dressings are changed daily or up to four times a week, depending on the study or hospital protocol. Transparent dressings have gained in popularity because they permit visualization of the underlying skin and insertion site. Transparent dressings also act as a bacterial barrier, permit oxygen transmission, facilitate passage of water vapor (Vasquez & Jarrard, 1984), are easy to apply, and may protect the insertion site from high humidity therapy devices (Dickerson, Horton, Smith & Rons, 1989).

Callahan and Wesorick (1987) studied the colonization of microorganisms under transparent dressings. Results revealed that colony counts under the dressings were lower than the normal skin population the first 48 hours. However, at 72 hours the colony count had increased

significantly. Lawson, Kavanagh, McCredie, Marts, Barbour, and Chandler (1986) studied transparent and gauze dressings over central venous catheter sites in 365 cancer patients. Transparent dressings were changed once a week and gauze dressings were changed three times weekly. Results indicated no significant differences in the incidence of phlebitis, site infection or suspected bacteremia between the two groups. An important finding of the study was the loss of integrity in the transparent dressing on the average of the fourth day. Lawson, et al. (1986) recommended changing the transparent dressing every four days. Conly, Grieves, and Peters (1989) compared the incidence of exit site colonization, catheter related infection and catheter related sepsis in central lines with gauze dressings and transparent dressings. Significant skin colonization occurred beneath transparent dressings when they were applied to the insertion site for extended periods of time, even when the dressing was changed three times weekly and the site was cleaned prior to application of a new dressing. Differences in the bacterial counts of gauze and transparent dressings were noted 98 hours after insertion of the catheter. Seven cases of catheter-related sepsis occurred in transparent dressings. None were reported in the gauze dressings. Conly, et al. (1989) recommended that transparent dressings be used only on a short-term basis.

Other insertion factors may play a role in the development of nosocomial infections. The unit of the hospital where insertion of the central venous catheter occurred may be a factor. Central venous catheters inserted in the Emergency Room or in the Intensive Care Unit have a higher risk of contamination during insertion than catheters inserted in the operating room (Massanari & Hierholzer, 1987). The reason for insertion of the central venous catheter is also a potential factor. For example, if a single-lumen catheter is inserted to administer fluids, the risk of infection is less than if a multiple-lumen catheter is inserted to administer blood, fluids, TPN, medication and to monitor central venous pressure (Lee et al., 1988; McCarthy et al., 1987; Pemberton et al., 1986; Powell et al., 1988; Rose et al., 1988; Yeung et al., 1988).

Catheter Related Bacteremia

According to Hamory (1987, p. 283), bacteremia is a "clinically important blood culture positive for a bacterium or fungus that is obtained more than 48 hours following hospitalization." Signs and symptoms of bacteremia include increased white blood cell count (WBC); chills (Viall, 1990); tachycardia; tachypnea; cool, clammy skin; decreased pulse pressure; oliguria; peripheral cyanosis; vascular collapse; intravascular coagulation (Brunner & Suddarth,

1986); fever greater than 38 degrees centigrade and hypotension (Garner, Jarvis, Emori, Horan, & Hughes, 1988).

The Center of Disease Control definition of laboratory confirmed primary bloodstream infections states one of the following criteria must be met:

1) A recognized pathogen must be isolated from the blood culture, and the pathogen is not related to infection at any other site.

2) At least one of the following must be present: fever greater than 38 degrees centigrade, chills, or hypotension. In addition any of the following may be present:

a) A common skin contaminant is isolated from two blood cultures drawn on different occasions. The contaminant is not related to infection at any other site.

b) A common skin contaminant is isolated from a blood culture and the patient has an intravascular access device, and the physician ordered appropriate antibiotics.

c) A positive antigen test on the blood and the organism is not related to an infection at any other site (Garner, et al., 1988).

The definitions of catheter related sepsis or bacteremia utilized in research studies determine the research protocol of the study. For example, Mantese, German, Kaminski and Herrmann (1987, p. 598) defined central

venous sepsis as "an episode of clinical sepsis associated with the growth of identical organisms from both the triple-lumen catheter tip and blood cultures without any other source of identifiable infection." Kelly, Ligas, Smith, Madden, Ross and Becker (1986, p. 15) developed three classifications of triple-lumen catheter sepsis: definite, probable and sepsis unrelated to triple-lumen catheter. Definite triple-lumen sepsis was defined as: "blood and triple-lumen cultures growing the same organism with no other site growing that organism." Probable triple-lumen sepsis was identified as "positive blood cultures with no other likely source of bacteremia." Sepsis unrelated to the triple-lumen catheter was defined as "positive blood cultures with the same organisms grown from another site more likely to represent the source." Blood cultures were obtained upon insertion and removal of the central venous catheter and catheter tip cultures were obtained upon removal of the catheter.

Other studies have included some of the clinical signs and symptoms of bacteremia in the definition of central venous catheter septicemia or bacteremia. Prager and Silva (1984, p. 459) defined catheter related septicemia "as organisms cultured from venous blood and whose findings of fever, hypotension and/or oliguria resolved upon withdrawal of the central venous catheter." Yeung, et al. (1988,

p. 155) defined secondary bloodstream infection "as the growth of the same organism in a peripheral blood culture that was grown from a catheter tip or from purulent drainage at the catheter site." Sitzman, et al. (1985, p. 767) defined suspected catheter sepsis as a "fever greater than ... 38.4 degrees centigrade, documented bacteremia or fungemia, overt cellulitis or purulent discharge at skin insertion site, or temperature below ... 36.5C and with systemic signs of sepsis." Young, Alexeyeff, Russell and Thomas (1988, p. 366) defined central venous catheter sepsis as "positive peripheral venous blood culture, evidence of systemic infection, no other obvious septic focus, resolution of fever after withdrawal of the central venous catheter and positive catheter tip culture."

Site Infection

Catheter insertion site infections include phlebitis, purulent thrombophlebitis, cellulitis and occult intravenous site infections. Catheter insertion site infections may occur with or without fever or bacteremia. Purulent thrombophlebitis, cellulitis and occult intravenous site infections are generally preceded or associated with phlebitis. Phlebitis is characterized by warmth and erythema over a tender or indurated vein. Phlebitis may be caused by infection, however, it is most frequently caused

by mechanical or chemical irritation from the cannula. In addition to the signs and symptoms of phlebitis, purulent thrombophlebitis will exhibit gross or microscopic evidence of pus. Cellulitis rarely exhibits pus and is characterized by warm, erythematous and sometimes tender and edematous skin surrounding the catheter insertion site. The most common catheter related infection, occult intravenous site infections normally do not produce any purulent drainage or inflammation. Often these infections do not exhibit any signs and symptoms in the early stages and culture of the catheter may be the only way to diagnose this infection (Simmons, 1983).

Signs and symptoms of central venous catheter site infections include erythema, purulent discharge, tenderness (Viall, 1990), increased warmth and induration (Plit, et al., 1988). Study protocols are based on the operational definition of catheter site infections. Dickerson, et al. (1989, p. 720) defined infection of the catheter insertion site as diagnosed by the physician or at "least three of the following: (1) redness, (2) purulent drainage, (3) temperature of at least 38°C at least twice in a 48-h period, (4) white blood cells $\geq 12,000/\text{mm}^3$ with segmented neutrophils predominating, and (5) isolation of a significant infectious agent." Pemberton, et al. (1986, p. 592) defined an infected central venous catheter insertion

site as "pus and inflammation with a positive culture in a patient with no clinical systemic sepsis that was caused by another organism proved by culture." Rose et al. (1988, p. 511) defined catheter site infection as occurring when "cultures at the exit site are identical to bacteria found on blood culture."

Summary

The review of literature supports the predicted relationships in the conceptual framework. At the construct level, intrinsic and extrinsic factors are theorized to be positively related to nosocomial central venous catheter infections. Intrinsic factors are those conditions that are inherent in the individual. Intrinsic or patient factors that have been shown to be positively related to nosocomial central venous catheter infections include: acute or chronic illnesses, trauma, compromised defense systems, previous infections, prolonged hospitalization, length of surgical procedure, and respiratory colonization and/or infection. Extrinsic factors are those conditions external to the patient and include central venous catheter insertion variables and other invasive medical devices. Extrinsic factors found to be positively related to catheter related bacteremia and central venous catheter site infections include: catheter insertion site, number of attempts at

catheter insertion, duration of catheterization, multiple-lumen catheters, and exchanging the central venous catheter via guidewire. The type of occlusive dressing used and frequency of dressing changes have also been identified as positively correlated to catheter related nosocomial infections.

CHAPTER 3

RESEARCH METHODOLOGY

The research method is described in this chapter including the research design, setting, sample, and data collection protocol. The instruments used to collect the data are reviewed and operational definitions of catheter related bacteremia and site infections are detailed. The data analysis plan is also addressed.

Research Design

A descriptive design was used to examine the relationships among intrinsic and extrinsic factors and nosocomial central venous catheter infections. The research focused on the control group of a larger quasi-experimental study entitled "The Effect of a Central Line Care Teaching Program on Bacteremia and Site Infection in Patients with Central Lines". The purpose of the proposed quasi-experimental research is to test the effectiveness of an educational program that teaches a standardized dressing change protocol on the incidence of catheter related bacteremia and site infections in patients with central venous catheters.

Setting

The setting was a fifteen bed Intensive Care Unit (ICU) and a 31 bed Medical-Surgical Unit (MSU) in a Southwestern Level 1 trauma center. The 256 bed teaching hospital is located in a large metropolitan area and serves a population of greater than 700,000. The hospital is also used as a referral facility for surrounding communities. A large Hispanic population is served due to the close proximity of the Mexican border.

Sample

The convenience sample consisted of patients in the Intensive Care Unit and the Medical/Surgical Unit. All subjects met the following criteria:

1. 18 years of age or older
2. able to give written informed consent
3. a central venous catheter inserted less than 48 hours prior to entering the study.

The central venous catheter may have been inserted in any department in the hospital. Severely immunosuppressed patients were excluded from the study to prevent exposing them to an increased risk of infection.

Protection of Human Subjects

The proposal was approved by the University of Arizona Human Subjects Committee as a minimal risk project (Appendix A). Written informed consent was obtained from the patient prior to entering the study (Appendix B). A consent written in Spanish was available due to the large Hispanic population served by the hospital (Appendix C).

Patient confidentiality was maintained by reporting the results of the study in group form. Signed consent forms and collected data were kept locked in the Office of Nursing Research. The patient had the right to withdraw from the study at any time.

Data Collection Protocol

The data collection protocol and data collection forms were developed by members of the Central Line Research Committee in the Department of Nursing of the Southwestern Hospital. Data collection forms included a demographic data sheet (Appendix D), a central line insertion information sheet (Appendix E) and a daily central line site inspection form (Appendix F). All data collection forms were pilot tested for clarity and completeness by two Intensive Care nurses and a Bone Marrow Transplant Nurse Specialist.

Rounds were made daily by the data collector in the Intensive Care Unit and the Medical/Surgical Unit. Patients

who met the study criteria were identified and were asked to participate in the research study. After written informed consent was obtained, demographic data and central line insertion information were obtained from the medical records. The central venous catheter insertion site was inspected daily for redness, tenderness, drainage, induration, type of dressing, and length of time the dressing was in place. In addition, the white blood cell count and highest temperature recorded that day was noted.

Blood cultures were drawn through the distal port of the central venous catheter every Monday, Wednesday and Friday. Several studies supported withdrawal of blood for cultures through the central venous catheter instead of peripherally. Maki (1986, p. 565) reported that "routine blood culture obtained through central venous catheters ... show reasonably good concordance with cultures drawn by conventional venipuncture..." Weightman, Simpson, Speller, Mott and Oakhill (1988) found that the concentration of pathogens in the blood drawn through the central venous catheter was at least ten times greater than in the peripheral venous blood culture. Mosca, Curtas, Forbes and Meguid (1987) showed that in patients with catheter related sepsis, blood cultures drawn through the central venous catheter had five times the number of colony counts than blood cultures drawn peripherally. Patients who exhibited

clinical signs of sepsis or had a positive central venous catheter culture were then treated in accordance with the hospital's clinical protocol. The protocol included peripheral blood cultures drawn from two different venous sites, culture of the insertion site if drainage was present and culture of the catheter tip upon removal of the central venous catheter.

Blood cultures were drawn through the distal port of the central venous catheter unless TPN was infused through that port. The heparin lock or tubing connection was swabbed with betadine and allowed to dry for one minute. Eight milliliters of blood was withdrawn from the port using a luerlock syringe. The blood sample was then injected into a Dupont Isolator 10 microbial tube and sent to the laboratory for culture. Aseptic technique was maintained to prevent contamination of the central venous catheter. Blood culture reports were forwarded to the Infection Control Nurse who reported positive blood cultures to the patient's physician for appropriate treatment. Blood culture reports were not filed in the patient's medical record.

Inspection of the central venous catheter insertion site was conducted daily. Redness and induration around the insertion site was measured with a ruler and recorded in centimeters. Drainage was recorded as either clear, opaque or bloody. Palpation surrounding the catheter site was done

to assess for tenderness and warmth. The insertion site dressing was inspected to determine if it was occlusive. Dressings were also inspected for notation of the date the dressing was changed. Interrater reliability was estimated when the data collectors inspected insertion sites separately and assessments were identical.

Members of the Central Line Research Committee collected data in November 1989. Data collection was suspended in December 1989 while the Hospital Infection Control Committee deliberated a revision in the central venous catheter dressing change policy. Data collection was resumed in May 1990. The suspension of data collection did not influence the results of the study since the dressing change policy and study protocol were not changed.

Operational Definitions

Catheter Related Bacteremia

A diagnosis of catheter related bacteremia was made if the patient exhibited clinical signs and symptoms of bacteremia: fever greater than 38 degrees centigrade, white blood cell count greater than 12,000mm³, and no other focus of infection was identified. One or more of the following criteria must also have been present:

1. positive quantitative blood culture of pathogen(s) in any amount

2. purulent drainage from insertion site which cultured the same organism as the central venous catheter blood culture

3. positive catheter tip culture that exhibits the same organism as central venous catheter blood culture.

Site Infection

Central venous catheter insertion site infection was diagnosed when any of the following five criteria were met:

1. tenderness greater than 3 centimeters
2. redness greater than 3 centimeters
3. any induration
4. any drainage other than intravenous fluids or blood from the insertion site
5. positive drainage culture: 3-4+ of one pathogen with white blood cells and organism on gram stain.

See Table 1 for a summary of concepts, conceptual definitions and operational definitions.

Data Analysis Plan

Descriptive statistics were used to analyze the demographic data and answer the research questions. The research questions were as follows:

Table 1
Identification of concepts and conceptual and operational definitions

Concept	Conceptual Definition	Operational Definition
Intrinsic Factors	Inherent in the individual	sex, age, diagnoses, medical history, surgeries
Extrinsic Factors	External to the individual	CVC insertion variables, invasive devices
Catheter related Bacteremia	Positive blood culture for bacterium or fungus	Clinical signs and symptoms of bacteremia (WBC>12,000mm ³ , fever >38°C). One or more of following must be present: 1. pathogen in blood culture 2. purulent drainage from insertion site grows the same organism as CVC blood culture 3. positive catheter tip culture that grows the same organism as CVC blood culture
Site Infection	Phlebitis, cellulitis, purulent thrombophlebitis, occult intravenous site infections.	Any of the following: 1. tenderness > 3cm 2. redness > 3cm 3. any induration 4. any drainage other than intravenous fluids or blood from the insertion site 5. + drainage culture: 3-4 + for one pathogen; with WBC and organism on gram stain.

1. What is the relationship between intrinsic factors and nosocomial infections in central venous catheters?

2. What is the relationship between extrinsic factors and nosocomial infections in central venous catheters?

Pearson Correlational Coefficients were computed to examine the relationships of the variables. The level of significance was set at $p \leq .05$.

Summary

A descriptive study was conducted to examine the relationships between intrinsic and extrinsic factors and central venous catheter nosocomial infections (catheter related bacteremia and central venous catheter insertion site infection) in patients with central venous catheters. The subjects were patients in the Intensive Care Unit or Medical/Surgical Unit of a Southwestern Teaching Hospital who had central venous catheters inserted less than 48 hours prior to entering the study. Blood cultures were drawn three times a week through the distal port of the central venous catheter. The insertion site was inspected daily for redness, induration, tenderness, drainage, and condition of the dressing. Data were analyzed using descriptive statistics.

CHAPTER 4

RESULTS OF DATA ANALYSIS

The results of the data analysis are presented in Chapter four. The characteristics of the sample and central venous catheter insertion characteristics are described. The results of the data analysis in relation to the research questions are also presented.

Characteristics of the Sample

The sample consisted of 30 subjects, five females and 25 males. Ages of the subjects ranged from 19 to 88, with a mean age of 55 years (Standard Deviation [SD]=19.62 years). Prior to entering the study, the subjects had been hospitalized from one to 48 days, with a mean of 9.8 days (SD=13.71 days). Nine subjects were in the Medical/Surgical Unit (30%) and 21 were in the Intensive Care Unit (70%). Eighteen subjects were admitted to surgical services (60%), four subjects were under medical services (13.3%) and the remaining eight subjects were admitted to trauma services (26.7%). The characteristics of the convenience sample are presented in Table 2.

Admission diagnoses were categorized by diseases of body systems and cancer. The most frequent admission diagnosis was vascular disease (30%) followed by

Table 2

Demographic Characteristics of Sample: Frequencies (N=30)

Variable	Number	Percentage
Gender		
Male	25	83.3
Female	5	16.7
Age		
18 to 20	3	10.0
21 to 30	2	6.7
31 to 40	3	10.0
41 to 50	3	10.0
51 to 60	5	16.7
61 to 70	9	30.0
71 to 80	3	10.0
81 to 90	2	6.7
Admission Unit		
MSU	13	44.8
ICU	12	41.4
Others	5	13.8
Days Since Admission		
1	5	16.7
2	6	20.0
3	5	16.7
4	1	3.3
5 to 10	6	20.0
11 to 20	3	10.0
21 to 30	1	3.3
31 to 40	0	00.0
41 to 50	3	10.0
Service		
Surgical	18	60.0
Trauma	8	26.7
Medical	4	13.3
Type of Room		
Private	24	80.0
Semi-private	6	20.0

Table 2

Demographic Characteristics of Sample: Frequencies (cont.)

Variable	Number	Percentage
Current Unit		
MSU	9	30.0
ICU	21	70.0
Days on Current Unit		
1	12	40.0
2	5	16.7
3	4	13.3
4	1	3.3
5 to 10	2	6.7
11 to 20	2	6.7
21 to 30	2	6.7
31 to 40	0	0.0
41 to 47	2	6.7

gastrointestinal (26.6%), trauma (26.6%), neurological (13.3%), respiratory (10%), cancer (10%), cardiovascular (6.6%), neurovascular (3.3%) and orthopedic (3.3%). The most frequent secondary diagnosis was cardiovascular disease (30.0%) followed by gastrointestinal problems (23.3%), hypertension (20%), respiratory problems (20%), vascular problems (13.3%), neurovascular problems (13.3%), diabetes mellitus (10.0%) and cancer (10%). (Table 3)

Abdominal surgeries accounted for 46.7% of the surgical procedures performed on the subjects followed by vascular surgery (26.7%), exploratory procedures (16.6%), neurological surgery (10%), orthopedic procedures (6.7%) and finally debridement (3.3%). The length of the surgical procedures ranged from 2 to 11 hours, with a mean of 5.98 hours.

Thirteen nosocomial infections were described in the hospital records of the subjects. Several subjects had more than one site of infection. The most frequent infection was wound infections which accounted for 13.3% of the infections followed by infections of the respiratory tract (10%), urinary tract (6.7%) and blood (6.7%). The most frequent infectious organisms were *Staphylococcus aureus* and *Pseudomonas* at 10% each followed by *Klebsiella* (6.7%), *Streptococcus* (6.7%) and *Candida* at 3.3%. (Table 4)

Table 3

**Demographic Characteristics Related to Diagnoses/
Procedures: Frequencies (N=30)**

Variable	Number	Percentage
Admission Diagnosis		
Vascular	9	30.0
Gastrointestinal	8	26.6
Trauma	8	26.6
Neurological	4	13.3
Cancer	3	10.0
Respiratory	3	10.0
Cardiovascular	2	6.6
Neurovascular	1	3.3
Orthopedic	1	3.3
Secondary Diagnosis		
Cardiovascular	9	30.0
Gastrointestinal	7	23.3
Hypertension	6	20.0
Respiratory	6	20.0
Vascular problems	4	13.3
Neurovascular	4	13.3
Diabetes Mellitus	3	10.0
Cancer	3	10.0
Surgical Procedure		
Abdominal	14	46.7
Vascular	8	26.7
Exploratory	5	16.6
Neurological	3	10.0
Orthopedic	2	6.7
Debridement	1	3.3
Length of Surgery		
2 _{>} to 3 _{<} hours	3	10.0
3 _{>} to 4 _{<} hours	3	10.0
4 _{>} to 5 _{<} hours	3	10.0
5 _{>} to 7 _{<} hours	2	6.7
7 _{>} to 9 _{<} hours	1	3.3
10 hours plus	5	16.7

Note. More than one admission diagnosis and secondary diagnosis is possible. Not every subject had surgery and some had more than one surgical procedure.

Table 4

**Demographic Characteristics Related to Infections in
the Sample: Frequencies (N=30)**

Variable	Number	Percentage
Sites of Infection		
Wound	4	13.3
Respiratory	3	10.0
Urinary Tract	2	6.7
Blood	2	6.7
Other	1	3.3
Infectious Organism		
Staphylococcus aureus	3	10.0
Pseudomonas	3	10.0
Klebsiella	2	6.7
Streptococcus	2	6.7
Candida	1	3.3

Central Venous Catheter Characteristics

The central venous catheter characteristics are presented in Table 5. The most common insertion site was the internal jugular vein (70%) followed by the subclavian vein (26.6%) and the external jugular vein (3.3%). The type of central venous catheter inserted in the subjects were: triple-lumen catheters (46.7%), double-lumen catheters (20%), single-lumen catheters (20%), and unknown (13.3%).

Four major reasons for insertion of a central venous catheter were identified. Almost all of the subjects had central venous catheters inserted for more than one reason. Central venous catheters were inserted for vascular access (66.7%), monitoring (53.3%), fluid administration (50%) and total parenteral nutrition (43.3%). The hours that the central venous catheter had been in place ranged from 24 to 288 hours with a mean of 123.2 hours (SD=59.04 hours) and a mode of 96.0 hours.

Description of Infections

Nosocomial infections were defined as catheter related bacteremia and site infections. A catheter related bacteremia was defined as: a pathogen in the blood culture; or purulent drainage from the insertion site that cultured positively the same organism as the central venous catheter; or a positive catheter tip culture that grew the same

Table 5

Description of Central Venous Catheters in Sample:
Frequencies (N=30)

Variable	Number	Percentage
Insertion Site		
Right Internal Jugular	18	60.0
Right Subclavian	4	13.3
Left Subclavian	4	13.3
Left Internal Jugular	3	10.0
Left External Jugular	1	3.3
Catheter Lumen		
Triple	14	46.7
Single	6	20.0
Double	6	20.0
Unknown	4	13.3
Catheter Type		
Multiple lumen	21	70.0
Cordis	4	13.3
Cordis and Swanz	4	13.3
Swanz	1	3.3
Reason for Insertion		
Vascular Access	20	66.7
Monitoring	16	53.3
Fluid Administration	15	50.0
Total Parenteral Nutrition	13	43.3
Unknown	3	10.0
Catheter Sutured		
Yes	25	83.3
Unknown	5	16.7
Insertion Complications		
None	26	86.7
Unknown	3	10.0
Multiple sticks	1	3.3
Guidewire Exchange		
No	27	90.0
Yes	2	6.7
Unknown	1	3.3

Table 5

Description of Central Venous Catheters in Sample:
Frequencies (continued)

Variable	Number	Percentage
Unit Catheter Inserted		
Operating Room	12	40.0
ICU	9	30.0
MSU	5	16.7
Unknown	3	10.0
Emergency Room	1	3.3
Person Inserting Catheter		
Unknown	12	40.0
Anesthesia	10	33.3
Resident	5	16.7
Intern	2	6.7
Attending	1	3.3
Hours Catheter in Place		
96 hours	6	20.0
72 hours	4	13.3
120 hours	4	13.3
168 hours	4	13.3
48 hours	3	10.0
144 hours	3	10.0
192 hours	3	10.0
24 hours	1	3.3
216 hours	1	3.3
288 hours	1	3.3

Note. More than one reason for insertion of the catheter was possible.

organism as the central venous catheter blood culture. Two blood cultures drawn through the central venous catheter met the criteria for catheter related bacteremia. Both catheters had been in place 120 hours or more. The culture from a right subclavian catheter grew 100+ colonies of *Pseudomonas* and the culture from a right internal jugular catheter grew 100+ colonies of *Candida*. A left internal jugular catheter tip culture taken at 144 hours, grew 0 to 10 colonies of *Klebsiella*. However, the blood culture was negative, therefore the criterion for catheter related bacteremia was not met. Table 6 lists positive blood cultures.

Blood cultures drawn from the central venous catheters of three subjects grew 0 to 10 colonies of Coagulase-negative *Staphylococci*. Maki (1986) states that fifteen or more colonies grown on culture is considered a positive culture. Therefore, the three cultures that grew Coagulase-negative *Staphylococci* were not considered positive. In addition, a central venous catheter blood culture drawn at a later date on one of the subjects was negative, which indicated contamination during withdrawal of the blood specimen.

Site infection was defined as any of the following: tenderness greater than 3 centimeters, redness greater than 3 centimeters, any induration, any drainage other than blood

Table 6

Description of Positive Blood Cultures in Sample (N=30)

Site	Hours Catheter in Place	Organism	Colony Count
RSC	120 hours	Pseudomonas Coagulase-negative Staphylococci	100+ 0 to 10
RIJ	144 hours	Candida	100+

Note. Blood cultures drawn through central venous catheter.

or intravenous fluids and positive drainage culture. Redness was noted on ten observations. Redness ranged from 0.5 to 2 centimeters and did not meet the criteria for site infection. Tenderness less than 3 centimeters was noted on five observations. No induration was observed. The only drainage noted was characterized as blood or intravenous fluids. Therefore, no site infections were identified.

Research Questions

The research questions were as follows:

1. What is the relationship between intrinsic factors and nosocomial infections in central venous catheters?
2. What is the relationship between extrinsic factors and nosocomial infections in central venous catheters?

Pearson Correlational Coefficients were computed to examine the relationships between intrinsic factors, extrinsic factors and nosocomial infections. The significant correlations ($p \leq .05$) are listed in Table 7. Daily observations ranged from one to seven days. Correlations were made between the intrinsic and extrinsic variables and daily observations that had a minimum subject size of eight. No significant relationships were found between intrinsic factors or those factors that are inherent in each individual and nosocomial infections. Four extrinsic factors (factors that are external to the

Table 7

Significant Relationships Between Extrinsic Factors:
Pearson Correlation Coefficients (N=30)

	Site Infection: Redness
Extrinsic Factors	
Hours catheter in place	-.43
Days Endotracheal Tube in place	-.70
Days on Antibiotics	-.58
Experience of Person inserting catheter	.52

* sign @ $p \leq .05$

individual) did show a relationship to redness, an indicator of central venous catheter site infections on the second day of observation. Hours the central venous catheter was in place, days the endotracheal tube was in place and days the patient was on antibiotics had a significant inverse relationship to redness of the central venous catheter insertion site. The greater the hours the catheter had been in place the less the redness ($r = -.43$) at the insertion site. The more likely an endotracheal tube was in place, the less the redness ($r = -.70$) of the central venous catheter insertion site. The more antibiotics the subject received, the less redness was observed at the insertion site ($r = -.58$). The less experience of the person inserting the catheter, the greater the redness ($r = .52$).

In addition, the number of central venous catheter lumens demonstrated a significant correlation ($p \leq .05$) to the hours that the catheter was in place (fourth day of observation). The more lumens the central venous catheter had the longer the central venous catheter was in place ($r = .04$). The second day of observation revealed a significant correlation between the length of time the peripheral intravenous line was in place and the hours that the central venous catheter was in place. The greater the hours the peripheral intravenous catheter was in place, the longer the central venous catheter was in place ($r = .02$).

Summary

The demographic characteristics of the sample and their central venous catheters were described in this chapter. Two catheter related bacteremias were identified for an overall infection rate of 6.7%. No central venous catheter site infections were noted. Pearson Correlational Coefficients were computed to answer the research questions. Four extrinsic factors demonstrated a significant correlation to redness, a sign of central venous catheter infection (hours the catheter was in place, days the endotracheal tube was in place, days on antibiotics and the experience of the person inserting the central venous catheter). In addition, the number of central venous catheter lumens and days the peripheral intravenous line was in place showed a significant correlation to hours the central venous catheter was in place.

CHAPTER 5

DISCUSSION AND IMPLICATIONS

The discussion and conclusions based on the results of the research are presented in the final chapter. Limitations of the study are identified and suggestions for future research are explored. Finally, applications for nursing practice and research are addressed.

Findings

Two subjects were identified as having catheter related bacteremia. Based on more than 100 prospective randomized trials, Maki (personal communication, 6 Oct 1990) stated the national rate of bacteremia caused by central venous catheters is 3.2%. The incidence of bacteremia for this study was 6.7%, twice the national average. Both cases of catheter related bacteremia were subjects who had been admitted to the Intensive Care Unit. Their central venous catheters had been in place more than 120 hours. The increased rate of catheter related bacteremia found in this study may be due to several reasons. First, the sample size was small. Second, the sample was not random and therefore may not have been representative of the patient population. Seventy percent of the subjects were from the Intensive Care Unit and only 30% were from the Medical/Surgical Unit;

however, Intensive Care patients comprise a smaller pool of potential subjects. Third, due to the increased acuity, Intensive Care patients have a greater risk of infection because of their illness, exposure to medical technology and compromised immune system (Massanari & Hierholzer, 1987).

Findings Related to the Conceptual Framework

The conceptual framework proposed that intrinsic (patient factors) and extrinsic factors (central venous catheter variables and other invasive medical devices) contribute to catheter related bacteremia and site infections. The conceptual framework was supported by a review of literature outlined in Chapter 3. Corona, Peters, Narr and Thompson (1990) also identified seven factors that increased the risk of infection related to central venous catheters. The seven risk factors were: duration of catheterization; severity of underlying illness; type of catheter; multiple lumens; functions of the catheter; use of plastic, transparent, occlusive dressings and other factors (reusable transducers, phlebitis, manipulation of catheter, improper insertion technique and inexperience of the inserter).

In the sample of 30 subjects, two met the criteria for catheter related bacteremia. No site infections were identified. Pearson Correlation Coefficients were computed

to examine the relationships between intrinsic and extrinsic factors and indicators of nosocomial infections. A minimum of eight observations were necessary to perform the Pearson Correlation Coefficients. The level of significance was set at $p \leq .05$. None of the intrinsic factors showed a significant correlation to nosocomial central venous catheter infections.

Four extrinsic factors were significantly related to redness, a sign of site infection. The number of days the subject received antibiotics showed an inverse relationship to redness, ie. the longer the subjects received antibiotics the less redness was observed. This is an expected finding due to antibiotics suppressing infections. The number of hours the catheter was in place and days the endotracheal tube was in place showed an inverse relationship to redness also. The inverse relationship was not the expected outcome based on the review of literature. Prager and Silva (1987), McCarthy, et al. (1987), Gil, et al. (1989), and Corona, et al. (1990) demonstrated that the longer the catheter was in place, the higher the incidence of nosocomial central venous infections. Endotracheal tubes have been identified as a source of infection due to the increased secretions that can contaminate the dressing and site (Ehrenkranz, et al., 1989). One possible explanation for the inverse relationship between endotracheal tubes and redness, could

be that the central venous catheter dressings were changed more frequently due to respiratory secretions. The person inserting the catheter had a positive relationship to redness. Corona et al. (1990) identified the experience of the person inserting the central venous catheter as a major factor in central venous catheter infections. Most of the central venous catheters were inserted by an unknown person (lack of documentation in the medical record) or by a physician from the Anesthesia Department.

The conceptual framework proposed that intrinsic and extrinsic factors are positively related to catheter related bacteremia and catheter site infections. The findings of the study did not support the proposed relationship between intrinsic factors and nosocomial central venous catheter infections. The relationship between four extrinsic factors and redness of the catheter site supported the proposed relationship between extrinsic factors and nosocomial central venous catheter infections.

Serendipitous Findings

Subjects who had been diagnosed with cancer for the first time and had recently undergone surgery refused to participate in the study. After three patients with newly diagnosed cancer refused to participate, the data collector began consulting the patient's nurse to determine the

mental/emotional status of the individual before approaching the subject. Newly diagnosed cancer patients and their families are going through the grieving process and are facing an uncertain future. They are confronted with different treatment choices and asked to decide what treatment regimen they want to try. They do not want to become involved in research that has no bearing on their illness. Patients who had undergone their second or third cancer operation were generally receptive to research and would participate in the study.

Patients who had suffered spinal cord injuries which resulted in paraplegia or quadraplegia, were often not emotionally ready to discuss research projects upon admission to the unit. However, these patients tended to be on the units for weeks and often could be entered into the study at a later date if they had a new central venous catheter inserted. The nurses were a valuable resource in determining the patients emotional status and willingness to discuss the research project.

Limitations and Suggestions

The small sample size limits the generalizability of the findings. Descriptive studies with large numbers of variables require large samples. In the primary study, a quasi-experimental research design, a minimum of 70 subjects

was recommended for both the control group and the experimental group. The small number of subjects can be attributed to several issues. The subjects had to sign an informed consent. Parents and spouses were not able to sign the consent, limiting the possible subjects especially in the Intensive Care Unit. Many patients were unable to give consent due to unconsciousness, decreased neurological functioning, paralysis due to medications for patients on ventilators, and confusion.

Another limitation of the study was due to the constraints placed by the proposed quasi-experimental design of the primary study. After data collection was completed on the control group, an educational program stressing the proper technique for the maintenance of central venous catheters and dressing changes was to be presented to all the nurses working on the units involved in the research study. Therefore, the study was restricted to two nursing units. When a subject was transferred out of the Intensive Care Unit, the subject was eliminated from the study unless they were transferred to the Medical/Surgical Unit. Therefore, subjects were not always observed the entire length of time the central venous catheter was in place.

Originally blood cultures were to be drawn daily through the central venous catheter. However, the frequency was changed to every other day due to physician concern

about excessive blood loss in Intensive Care patients who have blood work drawn frequently. Cases of central venous catheter bacteremia may have been missed because blood cultures were not drawn daily.

The sample needed to include all the patients on the Intensive Care and Medical/Surgical Unit who had a central venous catheter inserted less than 48 hours. This would have provided a large sample and would have been more representative of the patient population. However, limitations related to informed consent prevented all patients with central venous catheters from being included in the study.

Implications for Nursing Practice

It has been estimated that nosocomial bacteremia adds approximately \$6,000 to the total hospital bill and prolongs hospitalization by seven days (Corona, et al., 1990). Maki (personal communication, 1990) studied 150,000 peripheral venous catheters and 5,000 central venous catheters over three years. Maki found that 90% of all blood stream infections originated from central venous catheters.

Nurses need to be aware of the risk factors involved in the development of nosocomial central venous catheter infections and take actions to minimize the risk of infection. Intrinsic factors are inherent in the individual

and cannot be modified. However, extrinsic factors or factors external to the individual can be modified to decrease the risk of infection. For example, adherence to strict aseptic technique while manipulating the central venous catheter system (changing tubing, cleaning the insertion site, applying new dressings, adding medication, withdrawing blood specimens) will decrease the risk of infection. Controversy continues regarding gauze dressings versus transparent dressings. However, maintenance of a clean occlusive dressing is a key factor in decreasing the risk of infection. Dressings that are soiled or nonocclusive need to be changed immediately and not left in place until the scheduled dressing change.

Assessment of the patient is an important function of nursing. Nurses need to carefully assess the patient for signs of central venous catheter infections. Regular observation of the insertion site for redness, induration, tenderness, and purulent drainage is vital. Catheter related bacteremia is hard to diagnose. If the patient develops a fever greater than 38 degrees centigrade, white blood cells greater than 12,000mm³, oliguria and hypotension, bacteremia must be considered. If the patient has multiple invasive devices, they must all be suspected as the source of infection. The patient's physician should be notified of the patient's condition and the hospital

protocol followed regarding blood cultures and other laboratory studies to be performed.

Implications for Nursing Research

Research into the risk factors that contribute to the development of central venous catheter infections is a broad field of study. Future studies need a larger sample that is more representative of the patient population. One possible avenue of research is to compare infection rates in gauze dressings versus transparent dressings. Another possible study might be designed to describe the outcomes related to changing transparent dressings at different time intervals. Studies are also needed to compare infection rates in single-lumen catheters versus multiple-lumen catheters. Total parenteral nutrition infused in single-lumen catheters versus double- or triple-lumen catheters is another area that can be researched. Also, a study could be designed to investigate infection rates of central venous catheters infusing TPN versus infection rates for central venous catheters not infusing TPN.

Summary

The purpose of this study was to describe the relationship between intrinsic and extrinsic factors and central venous catheter infections in the acutely ill

patient. The convenience sample consisted of 30 patients who had central venous catheters in place for less than 48 hours prior to entering the study and who were able to give informed consent. A descriptive design was used to examine the relationships between intrinsic factors, extrinsic factors and catheter related bacteremia and site infection. Two cases of catheter related bacteremia were identified (6.7% infection rate). No cases of central venous catheter site infection were identified. Pearson Correlation Coefficients revealed no significant relationships between intrinsic factors and central venous catheter infections. Four extrinsic factors were significantly related to redness ($p \leq .05$): hours the catheter is in place ($r = -.43$), the days endotracheal tube was in place ($r = -.70$), days the patient received antibiotics ($r = -.58$), and the experience of the person inserting the catheter ($r = .52$). Hours the catheter was in place, the days the endotracheal tube was in place, and days the patient received antibiotics had an significant inverse relationship to redness, a sign of site infection. Due to the small nonrandom sample, generalizations can not be made concerning intrinsic and extrinsic factors and their relationship to central venous catheter infections.

APPENDIX A

HUMAN SUBJECTS APPROVAL



The University of Arizona

Human Subjects Committee
1690 N. Warren (Bldg. 526B)
Tucson, Arizona 85724
(602) 626-6721 or 626-7575

21 July 1989

Carol Rhoades, R.N., B.S.
5 West
University Medical Center

RE: A89.95 THE EFFECT OF A CENTRAL LINE CARE TEACHING PROGRAM ON BACTEREMIA
AND SITE INFECTION IN PATIENTS WITH CENTRAL LINES

Dear Ms. Rhoades:

We received your 13 July 1989 letter and accompanying revised consent form for your above referenced project. The procedures to be followed in this study pose no more than minimal risk to participating subjects. Regulations issued by the U.S. Department of Health and Human Services [45 CFR Part 46.110(b)] authorize approval of this type project through the expedited review procedures, with the condition(s) that subjects' anonymity be maintained. Although full Committee review is not required, a brief summary of the project procedures is submitted to the Committee for their endorsement and/or comment, if any, after administrative approval is granted. This project is approved effective 21 July 1989.

The Human Subjects Committee (Institutional Review Board) of the University of Arizona has a current assurance of compliance, number M-1233, which is on file with the Department of Health and Human Services and covers this activity.

Approval is granted with the understanding that no changes or additions will be made either to the procedures followed or to the consent form(s) used (copies of which we have on file) without the knowledge and approval of the Human Subjects Committee and your College or Departmental Review Committee. Any research related physical or psychological harm to any subject must also be reported to each committee.

A university policy requires that all signed subject consent forms be kept in a permanent file in an area designated for that purpose by the Department Head or comparable authority. This will assure their accessibility in the event that university officials require the information and the principal investigator is unavailable for some reason.

Sincerely yours,

Milan Novak

Milan Novak, M.D., Ph.D.
Chairman
Human Subjects Committee

MVN:ms

cc: Departmental/College Review Committee

APPENDIX B

SUBJECT'S CONSENT FORM FOR RESEARCH PROJECT

SUBJECT'S CONSENT FORM FOR RESEARCH PROJECT

The Effects of a Central Line Care Teaching Program on Bacteremia and Site Infection in Patients with Central Lines.

I AM BEING ASKED TO VOLUNTARILY PARTICIPATE IN A STUDY TO DETERMINE THE EFFECTS OF AN EDUCATIONAL PROGRAM FOR NURSES WHO CARE FOR PATIENTS WHO HAVE TUBES INSERTED INTO VEINS TO RECEIVE FLUIDS. THESE TUBES ARE CALLED CENTRAL LINES.

CATHETER RELATED INFECTIONS ARE COMMONLY SEEN IN PATIENTS IN THE ICU OR MSU. THIS STUDY WILL ATTEMPT TO DOCUMENT IF THESE INFECTIONS CAN BE DIAGNOSED EARLIER THAN THEY CURRENTLY ARE, AND IF A SPECIAL CATHETER CARE PROGRAM REDUCES THE CHANCE OF INFECTION.

PURPOSE

I am being invited to voluntarily participate in the above-titled research project. The purpose of this project is to determine the effects of an educational program for nurses who care for patients who have tubes (catheters) inserted into vessels (veins) to receive fluids. These tubes are called central lines.

SELECTION CRITERIA

I am being asked to participate because I am over the age of 18, a patient in the medical/surgical Intensive Care Unit (ICU) or 5E, the Medical/Surgical Unit (MSU), and have had a central line inserted in a large vein. Approximately 120 patients will be enrolled in this study.

PROCEDURE

If I agree to participate, I will be asked to agree to the following. Every other morning, as long as the central line is in place and I am a patient in the ICU or MSU, approximately 8cc's (about a half tablespoon) of blood will be taken from the central line (to be analyzed or cultured for signs of infection) by a registered nurse who has been trained to do so. Removal of the blood through the catheter for laboratory tests is a routine procedure. I will not feel any pain when the blood is taken. The blood tests will not be charged to my bill.

RISKS

I understand that there could be possible risks from this study. The risk is a possibility of infection from drawing blood from the inserted line. However, the chance of infection from withdrawing blood is remote. My dressing and central line will be monitored daily by nurses who will visit me in the ICU or MSU.

BENEFITS

I understand that the possible benefit of this research is to identify infections at an early stage. In addition, an educational program which decreases the incidence of infection may be established for nurses.

CONFIDENTIALITY

I understand that only the investigators, the doctor in charge of the laboratory when the blood is sent and my doctor will know the identification of the results of the blood tests. I will be given a code number and the results of the study will be reported in group form.

PARTICIPATION COSTS

There is no costs to me for participating in this study.

LIABILITY

I understand that financial compensation for physical injury is not available for wages lost, medical care, or hospitalization. I may ask questions at any time and withdraw from the study at anytime without affecting my medical care.

AUTHORIZATION

BEFORE GIVING MY CONSENT BY SIGNING THIS FORM, THE METHODS, INCONVENIENCES, RISKS, AND BENEFITS HAVE BEEN EXPLAINED TO ME AND MY QUESTIONS HAVE BEEN ANSWERED. I UNDERSTAND THAT I MAY ASK QUESTIONS AT ANY TIME AND THAT I AM FREE TO WITHDRAW FROM THE PROJECT AT ANY TIME WITHOUT CAUSING BAD FEELINGS OR AFFECTING MY MEDICAL CARE. MY PARTICIPATION IN THIS PROJECT MAY BE ENDED BY THE INVESTIGATOR OR BY THE SPONSOR FOR REASONS THAT WOULD BE EXPLAINED. NEW INFORMATION DEVELOPED DURING THE COURSE OF THIS STUDY WHICH MAY AFFECT MY WILLINGNESS TO CONTINUE IN THIS RESEARCH PROJECT WILL BE GIVEN TO ME AS IT BECOMES AVAILABLE. I UNDERSTAND THAT THIS CONSENT FORM WILL BE FILED IN AN AREA DESIGNATED BY THE HUMAN SUBJECTS COMMITTEE WITH ACCESS RESTRICTED TO THE PRINCIPAL INVESTIGATOR, CAROL RHOADES, RN, OR AUTHORIZED REPRESENTATIVES OF THE NURSING DEPARTMENT. I UNDERSTAND THAT I DO NOT GIVE UP ANY OF MY LEGAL RIGHTS BY SIGNING THIS FORM. A COPY OF THIS SIGNED CONSENT FORM WILL BE GIVEN TO ME.

SUBJECT'S SIGNATURE_____
DATE_____
PARENT/LEGAL GUARDIAN_____
EXPLAIN WHY SUBJECT CAN'T SIGN**INVESTIGATOR'S AFFIDAVIT**

I have carefully explained to the subject the nature of the above project. I hereby certify that to the best of my knowledge the person who is signing this consent form understands clearly the nature, demands, benefits, and risks involved in his/her participation and his/her signature is legally valid. A medical problem or language or educational barrier has not precluded this understanding.

INVESTIGATOR'S SIGNATURE_____
DATE

Revised: 7/89

APPENDIX C

SUBJECT'S CONSENT FORM FOR RESEARCH PROJECT

SPANISH

Forma de Consentimiento Para Proyecto
de Investigacion

Los Efectos de un Programa de Ensenasa en el Cuidado de
una Lina Central sobre Infecciones en el Sitio y
Bacteremia

SE ME ESTA PIDIENDO A QUE VOLUNTARIAMENTE PARTICIPE EN UN ESTUDIO PARA DETERMINAR LOS EFECTOS DE UN PROGRAMA EDUCACIONAL PARA ENFERMERAS QUE CUIDAN PACIENTES QUE TIENEN INSERTADO UN CATETER HACIA LAS VENAS POR DONDE RECIBEN FLUIDOS. ESTOS TUBOS SE LLAMAN LINAS CENTRALES.

INFECCIONES RELACIONADAS A CATERERES COMUNMENTE SE VEN EN PACIENTES EN CUIDADO INTENSIVO. ESTE ESTUDIO INTENTARA DE DOCUMENTAR SI ESTAS INFECCIONES PUEDEN SER DIAGNOSTIZADAS ANTES DE LO QUE CORRIENTEMENTE SON DIAGNOSTAZADAS, Y SI UN PROGRAMA ESPECIAL SOBRE EL CUIDADO DEL CATETER REDUZCA LA PROBABILIDAD DE INFECCION.

PROPOSITO

Se me convida que voluntariamente participe en el proyecto de investigacion ante-titulado. El proposito de este proyecto es para determinar los efectos de programas educational para enfermeras que cuidan pacientes que tienen tubos (cateteres) insterados hacia vasos sanguineos (venas) para recibir fluidos. Estos tubos se llaman linas centrales.

CRITERIO DE SELECCION

Se me pide que participe porque tengo mas de 18 anos de edad, soy paciente en la unidad de cuidado intensivo quirurgico/medical, y tengo una linea central insertada en una vena grande. Aproximadamente 120 pacientes seran inscritos en este estudio.

PROCEDIMIENTO

Si estoy en acuerdo a participar, se me pedira que este de acuerdo con lo siguiente. Cada otra manana, por mientras que la linea central este colocada y soy paciente en la unidad de cuidado intensivo, aproximadamente 8cc's (como media cucharada) de sangre se tomara de la linea central (para ser analizada o que se haga un cultivo en busca de infeccion) por una enfermera que ha sido entrenada hacerlo. El tomar sangre por medio del cateter para pruebas de laboratorio es un procedimiento rutinario en la unidad de cuidado intensivo. No sentire dolar cuando tomen sangre. No se me cobrara por estas pruebas de sangre.

RIESGOS

Entiendo que podria haber posibles riesgos con este estudio. El riesgo es la posibilidad de infeccion de tomar sangre de la linea insertada. Sin embargo, la probabilidad de infeccion debido a la tomada de sangre es remota. Mi vendaje y linea central sera revisada dariamente por las enfermeras que me visitaran en la unidad de cuidado intensivo.

BENEFICIOS

Entiendo que los beneficios posibles de esta investigacion son el indentificar infeccion en su etapa principiante. Ademias, un programa educational que pueda disminuir la incidencia de infeccion pueda ser establecido para las enfermeras.

CONFIDENCIALIDAD

Entiendo que nada mas los investigadores, el medico encargado del laboratorio cuando se evie la sangre y mi medico sabran la indentificacion de los resultados de las pruebas de sangre. Se me dara un numero en cifra y los resultados del estudio se reportaran en forma de grupo.

COSTO DE PARTICIPACION

No hay ningun costo a mi participando en este estudio.

RESPONSABILIDAD

Entiendo que compensacion monetaria por un dano fisico no esta disponible por sueldo perdido, cuidado medical, o hospitalizacion. Puedo hacer preguntas a cualquier tiempo y retirarme del estudio a cualquier tiempo sin afectar mi cuidado medical.

AUTORIZACION

ANTES DE DAR MI CONSENTIMIENTO, FIRMANDO ESTA FORMA, LOS METODOS, INCONVENCIAS, RIESGOS Y BENEFICIOS SE ME HAN EXPLICADO Y MIS PREGUNTA SE ME HAN CONTESTADO. COMPRENDO QUE PUEDO HACER PREGUNTAS A CUALQUIER TIEMPO Y QUE SOY LIBRE A RETIARARME DEL PROYECTO A CAULQUIER TIEMPS SIN OFENDER A NADIE O AFECTAR MI CUIDADO MEDICO. MI PARTICIPACION EN ESTE PROYECTO PUEDE SER TERMINADO POR EL INVESTIGADOR O POR EL PATROCINAOR POR RAZONES QUE SERIAN EXPLICADAS. INFORMACION NUEVA DESARROLLADA DURANTE EL CURSO DEL ESTUDIO QUE PUEDE AFECTAR MI BUENA VOLUNTAD A CONTINUAR EN ESTE PROYECTO DE INVESTIGACION, SE ME DARA A COMO ESTE DISPONIBLE. ENTIENDO QUE ESTA FORMA DE CONSENTIMIENTO SERA ARCHIVADA POR EL COMITE DE SUJETOS HUMANOS CON ACCESO RESTRINGIDO AL INVESTIGADOR PRINCIPAL, CAROL RHOADES, RN, O UN REPRESENTANTE DEL DEPARTAMENTO DE ENFERMERAS. COMPRENDO QUE NO PIERDO MIS DERECHOS LEGALES FIRMANDO ESTA FORMA. UNA COPIA DE ESTA FORMA FIRMADA SE ME DARA.

Sujeto_____
Fecha**DECLARACION JURADA DEL INVESTIGADOR**

Le he explicado, cuidadosamente, al sujeto el proposito del proyecto antedicho. Yo atestigo a lo mejor de mi entendimiento que el sujeto firmando esta forma de consentimiento entiende claramente el proposito, los requisitos, beneficios y riesgos implicados en participar en este estudio. Un problema medical o obstaculo debido a educacion o lenguaje no ha impedido un entendimiento claro de su participacion en este proyecto.

Firma de Investigador_____
Firma de Testigo_____
Fecha_____
Fecha

Revisado: 7/89

APPENDIX D

CENTRAL LINE DEMOGRAPHIC DATA

CENTRAL LINE DEMOGRAPHIC DATA

Hospital ID Number: _____ Date _____
Admission date: _____
Days since admission (include today): _____
Admission unit: _____ #days on admission unit _____
Current unit: _____ #days on current unit _____
Type of room: Private _____ Semi-private _____ Triple _____
Age: _____ Gender: male _____ female _____
Service: Medical _____ Surgical _____ Trauma _____
Admission diagnosis: _____

Secondary diagnosis: _____

Surgical Procedure: _____

Length of Surgical Procedure: _____
Infections: _____
Organism: _____

Admission vital signs

Temperature (include route): _____ Pulse _____
Respiration: _____ Blood Pressure: _____
Total WBC: _____ BUN: _____ Albumin _____

APPENDIX E

CENTRAL LINE INSERTION INFORMATION

CENTRAL LINE INSERTION INFORMATION

ID _____

Date _____

Person inserting line (check one):

_____ Med. Student

_____ Resident

_____ Intern

_____ Attending

_____ Other - state _____

Unit where inserted: _____

Insertion Site:

	Insert	Removal		Insert	Removal
<u>RIJ</u>	_____	_____	<u>LIJ</u>	_____	_____
<u>REJ</u>	_____	_____	<u>LEJ</u>	_____	_____
<u>RSC</u>	_____	_____	<u>LSC</u>	_____	_____

Reason for Insertion:

_____ Monitoring

_____ TPN

_____ Vascular Access

_____ other _____

Catheter type: (Check Lumen & Type)

Lumen: single _____ Swan Ganz _____

double _____ Vitacuff _____

triple _____ Cordis _____

Size of catheter:

_____ 7 Fr _____ 8.5 Fr _____ Other

Catheter sutured in place: _____ yes _____ no

Insertion Complications

_____ none _____ multiple sticks (>2)

_____ pneumothorax _____ hemothorax

Insertion of Invasive Devices:

Date Inserted	Date Removed
Foley catheter: _____	_____
NG Tube: _____	_____
Peripheral IV's _____	_____
Tracheostomy Tube: _____	_____
Endotracheal Tube: _____	_____
Arterial Line _____	_____
Drains: _____	_____
Ventriculostomy: _____	_____
Cerebral Bld Flowline: _____	_____
Dialysis Line: _____	_____

Medications:

Date Started	Date Discontinued
Antibiotics: _____	_____
Anti-fungal: _____	_____
Immunosuppressants: _____	_____
Steroids: _____	_____
Antivirals: _____	_____
Biologicals: _____	_____
Chemo Agents: _____	_____

Date of Last Dose: _____

Please list any routine medication prior to admissions:

APPENDIX F

DAILY PATIENT CHECKLIST

DAILY PATIENT CHECKLIST

ID _____ Date _____

Today's temperature (max & route): _____

Today's total WBC: _____ Not available _____

OBSERVATIONS:

REDNESS: _____ YES _____ NO cm: (actual number) _____

INDURATION: _____ YES _____ NO cm: (actual number) _____

DRAINAGE: _____ YES _____ NO

CLEAR: _____ YES _____ NO

OPAQUE: _____ YES _____ NO

BLOOD: _____ YES _____ NO

TENDERNESS: _____ YES _____ NO _____ UNABLE TO ASSESS

CONDITION OF DRESSING:

OCCLUSIVE: _____ YES _____ NO

TYPE: _____ opsite _____ gauze _____ both _____ other

DATED: _____ YES _____ NO #DAYS SINCE LAST CHANGE _____

BLOOD CULTURE (Central)

Negative: _____

Positive: _____

Organism: _____

Type: _____ HECL _____ Cl

BLOOD CULTURE (Peripheral)

Negative: _____

Positive: _____

Organism: _____

Type: _____ HECL _____ Clinical

CATHETER TIP CULTURE

Negative: _____

Positive: _____

Organism: _____

Count: _____

DRAINAGE CULTURE

Negative: _____

Positive: _____

Organism: _____

Count: _____

Revised: 8/89

APPENDIX G

PERMISSION TO USE FIGURES

REFERENCES

REFERENCES

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